**MARK UP VERSION OF AMENDMENTS**

**A.**

This invention is related to concurrently filed applications Serial No. 09/115,855**, pending** and Serial No. 09/115,856**, abandoned**, which are incorporated herein by reference.

**D.**

4. **(amended)** The method of claim 2, wherein the oxidizing step comprises simultaneous exposure of the layer of a silicide of the first metal to **[both]** an oxidizing gas and a reducing gas.

40. **(amended)** An integrated circuit made by the method of claim **[28]** **26**.

**REMARKS**

Claims 1 - 30, 36 - 40, and 46 - 80 are now pending.

**A.** Applicants have updated the references to the related applications.

**B.** Applicants added 35 claims and canceled 5 claims. With the claim additions, Applicants believe that an additional fee is due. Please charge the required fee—and any additional necessary fees, including extension of time fees—to the deposit account of Texas Instruments Incorporated, Account No. 20-0668.

**The specification enables claims 3 and 13.**

**C.** The specification provides clear guidance to ordinary artisans about how to make the inventions of claims 3 and 13—which are both limited to methods where the Si surface has been oxidized before depositing a metal on the silicon. The office action notes that refractory metals do not enter into significant reactions with silicon oxide. This may well be true for thick layers of silicon oxide. However, the office action has not shown that this is true for very thin layers of silicon oxide. With very thin layers, the metal may often react with the underlying silicon, as the silicon oxide layer is too thin to serve as an effective reaction barrier. As a case in point, Gardner *et*

*al.*'s 5,851,921 patent[1] (Gardner '921) discusses how artisans should avoid oxide layers above 50 angstroms when forming silicides with group VIII metals.[2] This implies that ordinary artisans might expect substantially thinner layers to have different behavior. This application clearly teaches how ordinary artisans can use thin silicon oxide layers as a base layer for the metal silicate dielectric.[3]

Thus, Applicants submit that the specification enables ordinary artisans to make and use the invention of claims 3 and 13.

**Claims 4 - 7, and 9 are clear and definite.**

**D.** Applicants have amended claim to remove the term "both". Applicants submit that the scope of claim 4 is unchanged.

**E.** Claim 6—and thus its dependent, claim 7—is limited to methods where "the reducing gas is selected from the group consisting of CO, H2, CH3, and combinations thereof." Applicants believe that this claim has sufficient antecedent basis.

**F.** Claim 9 refers to "the oxygen plasma". Applicants believe that this limitation has sufficient antecedent basis.

**Hsieh '035 does not anticipate claims 1 and 36 - 41.**

**G.** Claim 1 is limited to methods of "**fabricating a field-effect device** on an integrated circuit, comprising the steps of: providing a single-crystal silicon substrate; forming a metal silicate dielectric layer on the substrate; and **forming a conductive gate** overlying the metal silicate dielectric layer."

The office action does not show that Hsieh '035 fabricates a field-effect device. In reality, Hsieh '035 is directed to "This invention relates to a method of fabricating high dielectric constant insulators, particularly a dielectric material having a high quality index for use in the integrated semiconductor circuit technology, and to capacitors using same."[4] Additionally, the office action

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[1] Gardner '921 was cited in the previous rejection.
[2] Gardner '921, [2:25].
[3] See, e.g., Application, [8:21], [12:4], [18:1], and [21;12].
[4] Hsieh '035, [1:8].

alleges that Hsieh '035 teaches "forming a conducting gate 14 overlying the metal silicate dielectric layer". Applicants agree that conductive layer 14 is deposited on the $Ta_2O_5$ / $SiO_2$ mixture layer 12'. However, Hsieh '035 states that layer 14 is a capacitor electrode[5]—not a conductive gate of a field-effect device.

Since Hsieh '035 does not show "each and every element claimed[6]", a rejection under 35 U.S.C. 102 is improper. Applicants request allowance of claim 1 and its dependents.

**H.** Claim 38 is dependent upon "allowable" claim 16. Claim 40 is dependent upon "allowable" claim 28. Applicants request allowance of claims 38 and 40.

**Thakur '748 does not anticipate claims 1 - 3.**

**I.** Claim 1 is limited to methods of "**fabricating a field-effect device** on an integrated circuit, comprising the steps of: providing a single-crystal silicon substrate; forming a metal silicate dielectric layer on the substrate; and **forming a conductive gate** overlying the metal silicate dielectric layer."

The office action does not show that Thakur '748 fabricates a field-effect device. Thakur '748 states that his method is directed to "a dielectric material comprising a material containing metal and silicon atoms (hereinafter metal/silicon material) that is transformed into a dielectric material by heating the metal/silicon material in a reactive gas ambient.[7]" Thakur '748 states an intended use for his useful capacitive material: "The capacitive dielectric material of the present invention may be used in any capacitive type device and in particular in storage capacitors used in memory devices or in storage elements used in floating gate devices.[8]" Thus the office action has not shown that Thakur '748 teaches a field-effect device.

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[5] Hsieh '035, [3:15] ("A conductive layer 14 made of, e.g., doped polysilicon, a metallic silicide or a metal, is deposited on the oxide mixture layer 12' to form a capacitor having electrodes or plates 10 and 14 with the dielectric medium 12'.").

[6] The CAFC reiterated in Leinoff, 726 F.2d 734, 220 U.S.P.Q. 845 (Fed. Cir., 1984), that "to anticipate a claim, a prior art reference must show each and every element claimed."

[7] Thakur '748, [1:34].

[8] Thakur '748, [3:8].

Additionally, the office action alleges that Thakur '748 teaches "forming a conducting gate (66) overlying the metal silicate dielectric layer (See Fig. 7)." Applicants agree that conductive layer 66 is deposited on the $TiO_xSi_yO_z$ dielectric 65. However, Thakur '748 states that underlying layer 61 is a diffusion region.[9] Ordinary artisans understand that a conductive gate would overly a gate dielectric AND a channel region. Thus, ordinary artisans understand that Thakur '748 teaches a capacitor electrode, not a conductive gate of a field-effect device.

Since Thakur '748 does not show "each and every element claimed", a rejection under 35 U.S.C. 102 is improper. Applicants request allowance of claim 1 and its dependents.

**The Hsieh '035 and WOLF, VOL. 1 references do not render claims 2 and 42 obvious**

Applicants respectfully traverse examiner's interpretation of the prior art as rendering the invention obvious over this patent.

**J.** First, in regards to Hsieh '035, not only does Hsieh '035 not teach Applicants' invention of claim 2, it fails to suggest forming a metal silicate gate dielectric in a field-effect device.

**K.** The Office Action notes that WOLF, VOL. 1 describes various methods of forming a metal silicide. Thus, it seems that WOLF, VOL. 1 is being applied only as a reference against some of Applicants' particularized variations. Applicants submit that WOLF, VOL. 1 does not cure any of the deficiencies in the rejection noted above. Applicants repeat—by reference—the arguments above in favor of claim 1.

As such, Applicants submit that claims 2 and 42—and their dependents—are patentable over the cited art, because the references—taken together—would not have suggested the invention to those of ordinary skill in the art.

**The Thakur '748 and Leas '615 references do not render claims 4 - 7 obvious**

Applicants respectfully traverse examiner's interpretation of the prior art as rendering the invention obvious over this patent.

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[9] Thakur '748, [3:8].

**L.** First, in regards to Thakur '748, not only does Thakur '748 not teach Applicants' invention of claim 2, it fails to suggest forming a metal silicate gate dielectric in a field-effect device.

Leas '615 is non-analogous art

**M.** Applicants submit that ordinary artisans would not look to Leas '615 when determining suitable methods for fabricating field-effect devices on integrated circuits. According to the title, Leas '615 is concerned with "Hot Sand-Coal Cracking to Hydrodistillate Fuels". Ordinary artisans would consider this patent to be concerned principally with organic chemistry and the petroleum industry. Applicants believe that with the rich body of literature concerning silicon processing, ordinary artisans would not search organic chemistry references to determine suitable methods of forming metal silicates from metal silicides. As such, Leas '615 is non-analogous art, and should not be combined with the other references without a specific teaching or suggestion in the cited art.

Leas '615 seems to teach a reversible cycle, not formation of a layer of silicate

**N.** Leas '615 teaches using hot dicobalt silicide to recover both $H_2$ and $O_2$ in a dicobalt silicide to cobaltous orthosilicate to dicobalt silicide cycle within a reactor. Additionally, the dicobalt silicide is used to recover oxygen from the organic oxygenated coal oils—thus forming the cobaltous orthosilicate of the previous cycle. Leas '615 teaches that this use of the cobalt silicide reduces the amount of purchased $O_2$ and $H_2$ needed to upgrade coal.

Applicants submit that—without an explicit suggestion—ordinary artisans would not look to this reversible cycle or the oxygen recovery from coal to form the metal silicate dielectric layer.

Leas '615 does not cure any of the deficiencies in the rejection of the parent claims

**O.** Applicants submit that Leas '615 does not cure any of the deficiencies in the rejection noted above. Applicants repeat—by reference—the arguments above in favor of claim 2.

Applicants submit that claims 4 - 7—and their dependents—are patentable over the cited art, because the references—taken together—would not have suggested the invention to those of ordinary skill in the art.

**Hsieh '035 does not render claims 24 and 25 obvious**

Claim 24, 25, 39, and 44 are further limited

**P.** Claims 24, 25, 39, and 44 also contains additional limitations. These limitations include "the intermediate layer having a thickness less than 1 nanometer" and oxygen annealing this intermediate layer. Hsieh '035's silicide layer is between 4 and 16 nm thick[10], before it is oxidized. In contrast, Applicants claim is limited to methods where intermediate layers thinner than 1 nm are oxygen annealed. Thus, the claimed range is not a mere change in size, but at least a factor of four[11] less than Hsieh '035's teachings.

A previous Office Action asserted that this 4:1 ratio is not an apples-to-apples thickness comparison.[12] Applicants note that the claim limitation and Hsieh '035's description both refer to the thickness before oxidation. The fact that the materials being oxidized may be different points to unobviousness—not similarity.

Hsieh '035 limits its range to between 4 nm and 16 nm. However, Hsieh '035 teaches that maximum capacitance is found at a 7 nm thickness[13], and that "the relatively low capacitance produced at 4 nanometers of silicide is due to the formation of a layer of silicon dioxide between the silicon substrate 10 and the hafnium oxide-silicon dioxide mixture layer 12. . ." Applicants have not found where Hsieh '035 teaches that using repeated applications of 1 nm intermediate layers will get around this limitation of its useful method. Instead, Applicants submit that Hsieh '035 teaches away from oxidizing thin layers. As such, Applicants invention is a change in type, not merely a change in size.

Applicants submit that Claims 24, 25, and 39 are patentable over the cited art, because the references—taken together—would not have suggested the invention to those of ordinary skill in the art.

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[10] See Hsieh '035, Fig 3.
[11] (and may be more than a factor of 16).
[12] See paper 12, page 9, second dot.
[13] [Hsieh '035, 4:43].

**Conclusion**

**Q.** The specification enables claims 3 and 13. There is no evidence that very thin layers of silicon oxide prevent a reaction between a metal and an underlying silicon layer.

**R.** Claims 4 - 7 are now clear and definite. All terms in claims 4 - 7 and 9 have sufficient antecedent basis.

**S.** Hsieh '035 does not anticipate claims 1 and 36 - 41. Claim 1's limitations include "fabricating a field-effect device on an integrated circuit and forming a conductive gate overlying the metal silicate dielectric layer." Hsieh '035 relates to a method of fabricating high dielectric constant insulators, particularly a dielectric material having a high quality index for use in the integrated semiconductor circuit technology, and to capacitors using same."

**T.** Thakur '748 does not anticipate claims 1 - 3. Claim 1's limitations include "fabricating a field-effect device on an integrated circuit and forming a conductive gate overlying the metal silicate dielectric layer." Thakur '748 teaches materials useful in storage capacitors or as storage elements in floating gate devices.

**U.** The Hsieh '035 and WOLF, VOL. 1 references do not render claims 2 and 42 obvious. WOLF, VOL. 1 does not cure the deficiencies of Hsieh '035.

**V.** The Thakur '748 and Leas '615 references do not render claims 4 - 7 obvious. Leas '615 is nonanalogous art that does not cure the deficiencies of Thakur '748.

**W.** Hsieh '035 does not render claims 24 and 25 obvious. Hsieh '035 teaches away from oxidizing thin layers—such as the claimed intermediate layer which is thinner than 1 nm.

**X.** Applicants believe that the application is in condition for allowance. However, should Examiner have any further comments or suggestions, Applicants respectfully request that Examiner contact the undersigned in order to quickly resolve any outstanding issues.


Respectfully submitted,

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